

Claim Amendments

Please cancel claims 1, 2, 18, 19, 24 and 26, and amend claims 3, 4, 6, 8, 15, 20-23, 25 and 27-30 as follows:

- 5 1. (canceled) ~~A method for motion estimation in coding video data indicative of a video sequence including a plurality of video frames, each frame containing a plurality of coefficients at different locations of the frame, said method comprising:~~
- ~~—— selecting at least one reference frame for a given original video frame;~~
 - ~~—— partitioning said original video frame into rectangular blocks of coefficients;~~
 - 10 ~~—— forming at least one reference block of coefficients from an offset of the rectangular blocks;~~
- ~~computing the differences between said at least one reference block and the rectangular blocks; and~~
- ~~optimizing the offset.~~
- 15 2. (canceled) ~~The method of claim 1, wherein said selecting comprises:~~
- ~~obtaining M video frames for providing M reference frames, wherein M is a positive integer greater than or equal to one.~~
- 20 3. (currently amended) The method of claim [[2]] 4, wherein said forming comprises:
- for each of said rectangular blocks of coefficients and each permutation of a horizontal offset value X and a vertical offset value Y, obtaining M additional rectangular blocks of coefficients for providing M reference blocks, wherein each of said M reference blocks of coefficients is formed by selecting coefficients from the M reference frames, such
- 25 that the coefficients in the M reference blocks of coefficients are horizontally offset by distance X and vertically offset by distance Y from a corresponding coefficient in said rectangular block of coefficients.
- 30 4. (currently amended) ~~The method of claim 3 wherein said computing comprises:—A~~
method, comprising:

selecting M reference frames for a given original video frame from a video sequence having a plurality of video frames, each frame containing a plurality of coefficients, wherein M is a positive integer greater than 1;

partitioning said original video frame into rectangular blocks of coefficients; and

5 from each of the M reference frames:

forming at least one reference block of coefficients from an offset of the rectangular blocks; and

10 obtaining a block difference at least partially based on a summation of absolute values of differences between corresponding individual coefficients in for each of said M reference blocks, obtaining the difference between in each of said rectangular block blocks of coefficients and each said at least one reference block of coefficients for providing a block difference at least partially involving summation of the differences between corresponding individual coefficients in each block; and

optimizing the offset at least partially based on the block difference.

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5. (original) The method of claim 4, wherein said optimizing comprises:

for each of said rectangular blocks of coefficients, determining an optimal horizontal offset X and vertical offset Y, wherein said determining is based at least partially on minimizing a weighted sum of M block differences.

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6. (currently amended) The method of claim [[2]] 4, wherein each of the M video frames selected as the M reference frames is computed based on the same frame of original video.

25 7. (original) The method of claim 4, wherein the block differences for the M reference blocks are combined for providing a weighted sum having a plurality of weighting factors, and wherein each weighting factor in the weighted sum is determined at least partially based upon a quantizer parameter or the index of the reference frame subjected to that weight.

30 8. (currently amended) The method of claim [[2]] 4, wherein each of the M video frames selected as the M reference frames is computed by decoding the same frame of original video at a variety of quality settings.

9. (original) The method of claim 5, wherein motion is represented by a motion vector to be encoded in bits, and wherein said determining is also based on the number of bits needed to encode the motion vector.

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10. (original) The method of claim 5, wherein the set of M reference frames is divided into N sub-sets, such that each of the M reference frames belongs to precisely one of the N sub-sets, and wherein the process of determining the optimal horizontal offset X and vertical offset Y is repeated for each of said N sub-sets of reference frames, for indicating a set of N optimal horizontal offsets X and N vertical offsets Y.

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11. (original) The method of claim 5, wherein said determining of the optimal horizontal offset X and optimal vertical offset Y involves a discrimination against offsets with large magnitudes.

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12. (original) The method of claim 11, wherein the discrimination is at least partially dependent upon an index corresponding to which of the M reference frames is being considered.

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13. (original) The method of claim 10, where the number N may vary from one frame of video to another frame of video.

14. (original) The method of claim 11, where the number N may vary from one frame of video to another frame of video, and the determination of the number N involves analysis of block differences in the previous frame.

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15. (currently amended) The method of claim ~~[[3]]~~ 4, wherein for each rectangular block, the set of M reference blocks is divided into N sub-sets, such that each of the M reference blocks belongs to precisely one of the N sub-sets, and wherein the process of determining the optimal horizontal offset X and vertical offset Y is repeated for each of said N sub-sets of

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reference blocks, for indicating a set of N optimal horizontal offsets X and N vertical offsets Y.

16. (original) The method of claim 15, wherein the number N of sub-sets may vary from one block to another within the given frame of video, said variation either based upon explicit signaling in the encoded bit stream or upon a deterministic algorithm.

17. (original) The method of claim 16, wherein the size of a rectangular block in one of the N sub-sets is computed at least partially using the size of a rectangular block in another of the N sub-sets or the values of the horizontal offsets X and vertical offsets Y.

18. (canceled) ~~A coding device for coding video data indicative of a video sequence including a plurality of video frames, each frame containing a plurality of coefficients at different locations of the frame, said device comprising:~~

~~—— a motion estimation module, responsive to an input signal indicative of an original frame in the video sequence, for providing a set of predictions so as to allow a prediction module to form a predicted image; and~~

~~—— a combining module, responsive to the input signal and the predicted image, for providing residuals for encoding, wherein the motion estimation block comprises a mechanism for carrying out the steps of:~~

~~—— selecting at least one reference frame for a given original video frame;~~

~~—— partitioning said original video frame into rectangular blocks of coefficients;~~

~~—— forming at least one reference block of coefficients from an offset of the rectangular blocks;~~

~~—— computing the differences between said at least one reference block and the rectangular blocks; and~~

~~—— optimizing the offset.~~

19. (canceled) ~~The device of claim 18, wherein the step of selecting comprises the step of:~~

~~obtaining M video frames for providing M references frames, wherein M is a positive integer greater than or equal to one.~~

20. (currently amended) The device of claim [[19]] 21, wherein ~~the step of~~ said forming comprises ~~the step of~~:

obtaining M additional rectangular blocks of coefficients for providing M reference
 5 blocks, for each of said rectangular blocks of coefficients and each permutation of a
 horizontal offset value X and a vertical offset value Y, wherein each of said M reference
 blocks of coefficients is formed by selecting coefficients from the M reference frames, such
 that the coefficients in the M reference blocks of coefficients are horizontally offset by
 distance X and vertically offset by distance Y from a corresponding coefficient in said
 10 rectangular block of coefficients.

21. (currently amended) ~~The device of claim 20, wherein the step of computing comprises~~
~~the step of:~~ An encoder, comprising:

a motion estimation module, responsive to an input signal indicative of an original
 15 frame in a video sequence, for providing a set of predictions so as to allow a prediction
module to form a predicted image, wherein the video sequence including a plurality of video
frames, each frame containing a plurality of coefficients at different locations of the frame;
and

a combining module, responsive to the input signal and the predicted image, for
 20 providing residuals for encoding, wherein the motion estimation block is configured for
selecting M reference frames for a given original video frame in said plurality of
video frames, wherein M is a positive integer greater than 1;

partitioning said original video frame into rectangular blocks of coefficients; and
from each of the M reference frames:

25 forming at least one reference block of coefficients from an offset of the rectangular
blocks; and

obtaining a block difference at least partially based on a summation of absolute
values of differences between corresponding individual coefficients in for each of said M
reference blocks, the difference between in each of said rectangular block blocks of
 30 coefficients and each said at least one reference block of coefficients for providing a block

~~difference at least partially involving summation of the differences between corresponding individual coefficients in each block; and~~

optimizing the offset at least partially based on the block difference.

- 5 22. (currently amended) The device of claim 21, wherein ~~the step of~~ said optimizing comprises ~~the step of~~:

determining, for each of said rectangular blocks of coefficients, an optimal horizontal offset X and vertical offset Y, wherein said determining is based at least partially on minimizing a weighted sum of M block differences.

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23. (currently amended) A computer readable medium having embedded therein a software program for use in motion estimation in coding video data indicative of a video sequence including a plurality of video frames, each frame containing a plurality of coefficients at different locations of the frame, said software program comprising:

- 15 ——— a code for selecting at least one reference frame for a given original video frame;
 ——— a code for partitioning said original video frame into rectangular blocks of coefficients;
 ——— a code for forming at least one reference block of coefficients from an offset of the rectangular blocks;
 20 a code for computing the differences between said at least one reference block and the rectangular blocks; and
 a code for optimizing the offset programming codes for carrying out the method according to claim 4.

- 25 24. (canceled) The software program of claim 23, wherein the code for selecting said at least one reference frame comprises:

a code for obtaining M video frames for providing M references frames, wherein M is a positive integer greater than or equal to one.

- 30 25. (currently amended) The ~~software program~~ computer readable medium of claim [[24]] 23, wherein said ~~the code for forming said at least one reference block~~ comprises:

a code for obtaining M additional rectangular blocks of coefficients for providing M reference blocks, for each of said rectangular blocks of coefficients and each permutation of a horizontal offset value X and a vertical offset value Y, wherein each of said M reference blocks of coefficients is formed by selecting coefficients from the M reference frames, such that the coefficients in the M reference blocks of coefficients are horizontally offset by distance X and vertically offset by distance Y from a corresponding coefficient in said rectangular block of coefficients.

26. (canceled) ~~The software program of claim 25, wherein the code for computing the differences comprises:~~

~~— a code for obtaining, for each of said M reference blocks, the difference between said rectangular block and each said reference block of coefficients for providing a block difference at least partially involving summation of the differences between corresponding individual coefficients in each block.~~

27. (currently amended) ~~The software program~~ computer readable medium of claim [[26]] 25, wherein said ~~the code for optimizing the offset~~ comprises:

~~a code for determining, for each of said rectangular blocks of coefficients, an optimal horizontal offset X and vertical offset Y, wherein the determination is based at least partially on minimizing a weighted sum of M block differences.~~

28. (currently amended) ~~The software program~~ computer readable medium of claim [[26]] 23, ~~further comprising~~

~~a code for combining~~ wherein the block differences for the M reference blocks are combined for providing a weighted sum having a plurality of weighting factors, and wherein each weighting factor in the weighted sum is determined at least partially based upon a quantizer parameter or the index of the reference frame subjected to that weight.

29. (currently amended) ~~The software program~~ computer readable medium of claim [[27]]

23, wherein the set of M reference frames is divided into N non-overlapping subsets, and wherein the code for determining the optimal horizontal offset X and vertical offset Y repeats

the process for each of said N sub-sets of reference frames, for indicating a set of N optimal horizontal offsets X and N vertical offsets Y.

30. (currently amended) The ~~software program~~ computer readable medium of claim 25,

5 wherein for each rectangular block, the set of M reference blocks is divided into N non-overlapping sub-sets, and wherein the code for determining the optimal horizontal offset X and vertical offset Y repeats the process for each of said N sub-sets of reference blocks, for indicating a set of N optimal horizontal offsets X and N vertical offsets Y.

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